(almost) everything you wanted to know about...

Soldering

Contributed by **Thijs Beckers, Luc Lemmens,** and **Jan Visser** (Elektor Labs)

Q *What's a good soldering iron for electronics?*

A From 8-watt pencil to 150-watt "poker", it depends on your goal. If you occasionally have a bit of soldering to do and do not expect to embark on large jobs, it's sufficient to use a cheap mains operated soldering iron with a power from 25 to about 40 watts. At these lower power levels, the solder tip is usually small enough for electronics; at power levels above 40 watts roughly, the solder tip is usually unwieldy.
But if you have more extensive soldering to do and especially if you are planning on doing SMD work, a temperature-controlled 'iron' rated at about 100 watts is recommended. Such stations usually come with a diversity of solder tips, which together with the temperature control feature make the station suitable for large and small solder joints. Nowadays cheap soldering stations are available too but keep in mind that for no-name equipment the availability of spare tips can be a problem. Although cheap products aren't necessarily bad, if you are after a product you can enjoy using for years, you should not cut back on it.

Q *What is the best temperature for a soldering iron?*

A That depends on a number of things:

- lead-free solder tin (higher melting point) or leaded (lower melting point);
- tip thickness / heating capacity / heating element construction / solder station quality;
- soldering to a small pad or a large ground plane;
- personal soldering habits — for "slow" soldering (i.e. long tip-to-component contact time) set a relatively low temperature; for "fast" soldering, set a high temperature. Too hot soldering will cause flux evaporation or component overheating.

Q *How can I prevent the solder tin from appearing dull?*

A Both the temperature and the duration of the heating process must be correct. Make sure that the solder joint (i.e. the metal surfaces to be joined) is properly preheated to (almost) the melting point of the tin before adding it. If not there is a fair chance of the flux evaporating before it can do its job. BTW RoHS compliant solder tin always becomes dull.

Q *Which solder tin is best?*

A That is often a personal preference. At Elektor Labs we use tin/lead solder wire with resin core (flux) for our prototypes — the flux cleans the surfaces where the solder joint is to be made, and ensures that the tin flows beautifully. Note that lead/tin solder wire is still permitted for use in prototypes, but not in the production of equipment!
For larger work like through-hole (TH) parts we use solder wire with a diameter of 0.8 mm to 1 mm; for SMDs, 0.5 mm works much better.

Q *When do you use solder paste?*

A Mainly when using an SMD oven or hot-air (gun/pencil) soldering. But sometimes it's also useful to use a dispenser or pointed object to apply solder paste in advance to a spot that is not easily accessible.

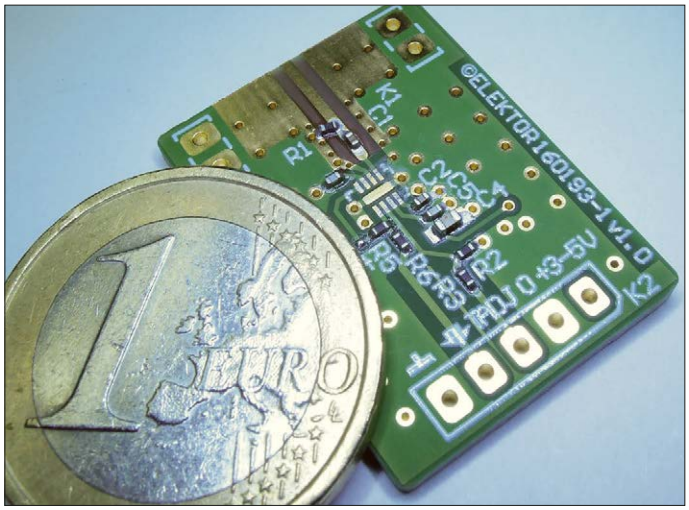
Q *Why do you use flux?*

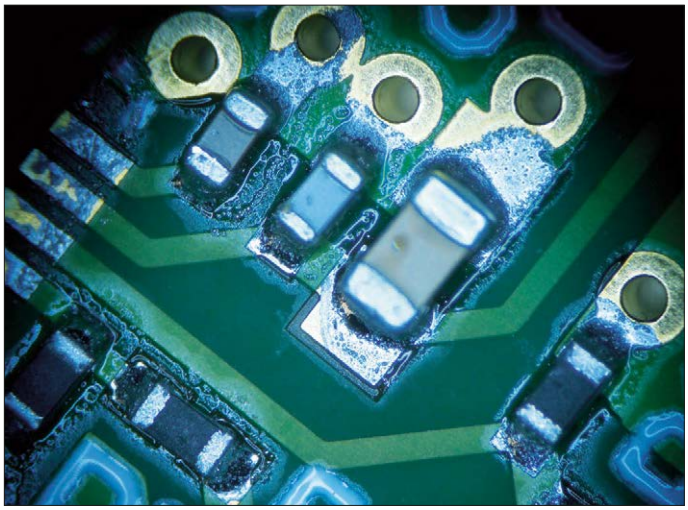
A Flux breaks the surface tension of molten tin and causes it to flow neatly. It also has a slight etching and cleaning effect on metal surfaces, which ensures proper adhesion of the tin.
There are many types of flux available with different chemical compositions. A specific type usually indicated as “no-clean” does not require after treatment, while others need to be removed after soldering because they are (slightly) conductive, or their etching effect continues and in time causes poor connections.

Note: officially, cleaning agents should not be necessary if the tip is regularly wiped clean, but it does no harm to properly inspect the tip before and after each soldering session. Damage to the coating is unavoidable however and will prompt tip replacement sooner or later.

Q *What and how to desolder?*

A Use a regular solder iron, possibly with a suction pump (hand operated or electric) and/or a desoldering iron (if necessary with extra flux) to remove as much solder tin as possible.





Q *How do I keep my soldering iron clean?*

A First and foremost, a clean solder tip is an absolute requirement for good soldering work. A contaminated or corroded tip results in poor heat transfer to the solder joint. Therefore, wipe the tip frequently (best after each connection) on a damp sponge or dry metal scouring pad.

- Do not heat up the soldering iron unnecessarily and switch it off immediately after use. A hot surface oxidises faster. Also, flux remnants carbonise, forming small black dots in the solder tin.
- On a damp (not: soaking wet) sponge you can wipe the solder tip clean. Do it with a quick swipe, otherwise the sponge burns and cools the tip down possibly to the extent of solidifying tin which precludes proper cleaning.
- A metal scouring pad. Contrary to what the name suggests, the intention is to lightly wipe the tip clean on the pad — real sanding would irreparably damage or even remove the metal coating from the tip.
- A product called ‘tip activator’ can aid in removing stubborn spots of oxidation and contaminations from the tip. The heated tip is dipped into the activator and lightly moved up and down, after which the contaminants on a metal abrasive sponge can be cleaned away. Trim the tip richly with fresh, fluxed solder tin, wipe clean again on the sponge and finally pre-tin lightly again. Instead of (fairly expensive) activator, flux can also be used in this process, but usually several cleaning cycles are required to achieve the desired result.

A hot-air pencil or gun is not only useful for soldering or removing SMD components, it can also be very useful for desoldering TH parts. It can be used to melt several solder joints simultaneously, for example three legs of a transistor are heated simultaneously to remove the component in one go. However, be careful with nearby plastic parts like connector housings and wiring, which may melt and burn before you can say Jack Robinson.
When it’s not terribly important for the component to survive the desoldering operation, it is often handy to cut off the legs and then desolder them one by one.
After removing a component, always remove as much solder as possible with the suction pen or desoldering braid. The latter will leave resin residues on the board surface, which require cleaning with IPA or a special PCB cleaner before installing new components.

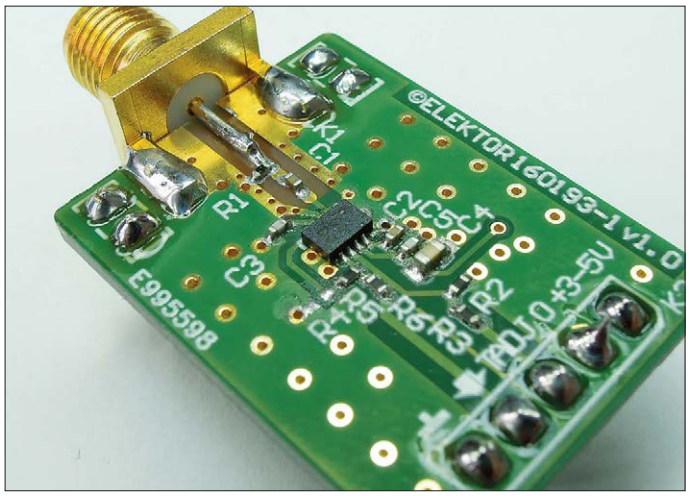
Q *What do I use to solder SMA parts a.k.a. SMDs?*

A Larger SMDs can still be handled with a small soldering iron, preferably with a thin tip and thin, resin-cored solder wire. But the smaller the components become, the more difficult the job, see the images in this article. For example, resistors and capacitors of size 0805 or smaller tend to stick to the solder tip instead of remaining on the PCB. Likewise, the smaller the pin spacing of ICs, the greater the risk of solder bridges forming short circuits. That too can be solved, but there will be a point at which working with solder paste in combination with a hot-air pencil or even an SMD oven is the only option. Moreover, there are components (especially ICs) whose

connections can no longer be reached with a soldering iron. The purchase of a hot-air station should not be a dramatic financial loss — under 100 euros will buy you an acceptable station. An oven is not absolutely necessary for most parts, but it is a must-have for larger circuit boards or small-volume productions.

Q *How do I solder a component with a BGA housing?*

A A component with ball grid array (BGA) connections can only be soldered with hot air, meaning in an oven or using a hot-air station. The most important things are the correct amount of solder tin (i.e. the diameter of the balls on the component), the absolute cleanliness of the PCB pads (remove all tin with desoldering braid) and a sufficiently high temperature to warrant for all connections. Here now we assume a new delivered part with the right size of solder balls on the



connections, a clean board and the use of a high-end hot-air station. Apply a reasonable amount of flux to the BGA terminals on the PCB. Position the IC as far to the very best of your ability, observing the marking(s) for pin 1. The temperature and airflow settings can be determined experimentally and will be different for each station and each nozzle. Take into account the temperature of any plastic headers or other 'sensitive' parts in the direct vicinity: these may be able to withstand 300 degrees C but should not be challenged. In case of doubt, apply protective Kapton tape (refer to the datasheet). When using airflow, avoid blowing other components off the board. The exact skill is to get sufficient heat energy conveyed with temperature and airflow combined. Heat the IC and the PCB. A circular movement is the best way to achieve this. Also heat an extra area of about 1-2 cm around the IC in order to heat the PCB sufficiently. Initially the flux will go in all directions, but a part will remain under the IC and will ensure a good flow of the tin. When all the tin has melted, the IC — if correctly positioned — will align itself in exactly the right place. Pay close attention during the heating: the alignment happens quite suddenly and at the same time it's a sign that all the tin has melted and that the IC is in place. When the hot air gun is now moved back and forth quickly, you should be able to see the IC 'swaying' a little bit on the molten grid balls. Then it's perfect. Limit this to 2-3 seconds and then remove the pencil/gun. Allow the IC to cool down gently. Afterwards, the flux can be cleaned with IPA (or in an ultrasonic bath). Presto! To be sure, measuring whether a short circuit has occurred between supply voltage and ground is not a bad thing.

Q *Do I need a fume extractor?*

A Fumes from modern solder wire alone are not known to be toxic or hazardous in small amounts but they can cause irritation and trigger certain allergies. Burnt plastics though are very undesirable. These risks, and your housemates, should be enough reason to ventilate your e-workspace, or even better, buy a fume extractor. Now available from the Elektor Store is a fume extractor for table top use (SKU 18450 on www.elektor com). It extracts solder fumes either horizontally through a rectangular opening in the case, or through a flexible hose and mouthpiece assembly you can mount optionally. ⏮

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Sanding and filing

Note: the following does not refer to soldering irons used in electronics. Only if your solder tip is made of copper you may clean it with a file or a piece of sandpaper. Otherwise, **never**. The surface of a solder tip typically applied in electronics is covered with a layer of silver, which is removed or at least damaged by sanding or abrasive action. This will only make the soldering worse instead of easier. Also, any scratches you make with sandpaper quickly fill with small debris deteriorating the soldering process.